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Synergies among climate change and biodiversity conservation measures and policies in the forest sector: A case study of Southeast Asian countries

Kanako Morita[a,*], Ken'ichi Matsumoto[b]

[a] Forestry and Forest Products Research Institute, 1 Matsunosato, Tsukuba, Ibaraki 305-8687, Japan
[b] Nagasaki University, 1-14 Bunkyo-machi, Nagasaki 852-8521, Japan

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ABSTRACT

Forest conservation contributes to climate change mitigation, adaptation, and biodiversity/ecosystem conservation. To enhance the co-benefits of forest conservation, it is important to promote synergies among the three measures—mitigation, adaptation, and biodiversity/ecosystem conservation—in the forest sector and eliminate the overlaps among the three measures. However, limited research exists on the analysis of their synergies. This study explores the potential for synergy among the three forest sector measures, utilizing: 1) indicators that assess enabling conditions for synergies among the three measures at the different institutional levels of policies and strategies, institutional arrangements, and financing and programs/projects; and 2) case studies of five countries in Southeast Asia: Thailand, Indonesia, Vietnam, Lao PDR, and Cambodia.

This analysis shows that the five countries all require various changes at different institutional levels in order to enhance their synergy potentials. The findings indicate the importance of national actors, financial mechanisms, programs, and projects in addressing the three measures. In terms of national actors, Thailand has the highest synergy potential due to its national-level committees and a single ministry that addresses all three measures. To enhance their synergy potentials, the other countries need to create national-level committees that address the three measures, and/or they need to enhance collaboration between the various ministries that represent the environment and forestry issues. At the financing and program/project aspects, Vietnam has the highest synergy potential. The other four countries need to develop common national funds that finance the three measures and/or develop joint programs and projects that address the three measures simultaneously.

1. Introduction

The governance of climate change mitigation, adaptation, and biodiversity and ecosystem conservation measures is generally discussed under different conventions: mitigation and adaptation fall under the United Nations Framework Convention on Climate Change (UNFCCC), while biodiversity and ecosystem conservation fall under the Convention on Biological Diversity (CBD). However, there is growing interest in integrating these climate change measures and biodiversity/ecosystem conservation (hereafter "conservation") measures, with a view to reducing their negative impacts and increasing their effectiveness and efficiency. For example, under the CBD, there has been discussion regarding the promotion of ecosystem-based approaches to mitigation and adaptation (CBD decisions X/33 and XI/21). Further, the United Nations Environment Programme (UNEP) has explored ecosystem-based approaches to mitigation and adaptation (Doswald and Osti, 2011), and has implemented an ecosystem-based adaptation program (UNEP, 2016).

It is true that the approaches used for mitigation, adaptation, and conservation are different. Mitigation focuses on greenhouse gases, and aims to reduce the sources or enhance the sinks of greenhouse gases (IPCC, 2014). Adaptation is the process of adjustment to actual or expected climate change and its effects (IPCC, 2014). Conservation aims to preserve the variability among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems (the definition of biodiversity from the CBD Article 2), and to conserve the dynamic complex of plant, animal, and micro-organism communities, and their non-living environment, whereby they interact as a functional unit (the definition of ecosystem from the CBD Article 2). The outcomes of mitigation measures are evaluated by quantifying greenhouse gas emissions and removals, and mainly produce global benefits. However, the outcomes of adaptation and conservation measures are difficult to quantify because (in contrast to mitigation efforts) there is no single indicator to evaluate outcomes. Adaptation and conservation measures mainly produce regional and local benefits (IPCC, 2007; Ingram et al., 2012).

* Corresponding author.
E-mail addresses: kanakomorita@ffpri.affrc.go.jp (K. Morita), kenichimatsu@nagasaki-u.ac.jp (K. Matsumoto).

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Furthermore, apart from the UNFCCC and CBD, the Intergovernmental Panel on Climate Change (IPCC) provides policymakers with regular assessments of the scientific basis of climate change, its impacts and future risks, and options for adaptation and mitigation (IPCC, 2013); in response to requests from decision makers, the Intergovernmental Science–Policy Platform on Biodiversity and Ecosystem Services (IPBES) assesses the state of biodiversity and of the ecosystem services it provides to society (IPBES, 2017), both of which touch on the relationship between climate change and biodiversity/ecosystems (e.g., IPCC, 2014; Ferrier et al., 2016).

Furthermore, the CBD and the IPBES acknowledge the importance of indigenous and local knowledge in their work and explicitly support a diversity of knowledge systems to inform international biodiversity assessments and decision making (Tengö et al., 2017). Both the CBD and IPBES respect traditional knowledge, innovation, and practices (CBD Article 8(j)). In the CBD's Strategic Plan for Biodiversity 2011–2020, including the Aichi Biodiversity Targets adopted in October 2010 at the CBD Conference of the Parties (COP), Target 18 (focusing specifically on traditional knowledge and customary sustainable use) is the main target related to the implementation of two of the most relevant articles of the CBD for indigenous people and local communities – CBD Article 8(j) and Article 10(c) – and represents a cross-cutting theme for the entire Strategic Plan (Forest Peoples Programme et al., 2016). The role of indigenous peoples and local communities in conservation has been valued in different agendas under the CBD, such as cross-cutting issues on biodiversity for development and climate change and biodiversity. With regard to biodiversity for development, the secretariat of the CBD reviewed the existing knowledge about the link between biodiversity conservation and poverty reduction, including the biodiversity-poverty link at the local level (SCBD, 2010). Encouraging the involvement of indigenous peoples and local communities in the discussion regarding integrating biodiversity, poverty eradication, and sustainable development/sustainable development goals has been stated in two CBD decisions: XII/5 and XII/4. Regarding decision XIII/3, the COP not only recognized the central role of indigenous peoples and local communities in the conservation and sustainable use of biodiversity; it also called for the effective engagement of subnational and local governments, for example, in raising the awareness of subnational and local governments of the importance of biodiversity and ecosystems services and functions and of the role of indigenous peoples and local communities in the holistic conservation, preservation, sustainable use, and management of biodiversity. It also considers the establishment of strategies for the strengthening of contributions of subnational and local governments in the implementation of the Strategic Plan and of the respective national biodiversity strategies and action plans. As for the issue of climate change and biodiversity, the role of indigenous peoples and local communities has been discussed in the context of one of the climate change mitigation measures, i.e., reducing emissions from deforestation and forest degradation, etc., in developing countries (REDD+), introduced under the UNFCCC. REDD+ contributes not only to mitigation but also to biodiversity conservation through its safeguard system. The secretariat of the CBD outlined the potential benefits of REDD+ for biodiversity and indigenous and local communities, demonstrated the importance of biodiversity and indigenous and local community co-benefits for the long-term success of REDD+, and outlined possible risks of REDD+ for biodiversity and indigenous and local communities (SCBD, 2011). The SCBD (2011) also touched on providing incentives for REDD+ to local forest users, including alternative sustainable livelihood options. Considerations of indigenous peoples and local communities in the implementation of REDD+ have been stated in decisions X/33 and XI/19 of the CBD.

Compared to the conservation field, the debate on climate change only includes limited discussion regarding the role of indigenous peoples and local communities, and their knowledge. Although the framework of REDD+ has been thoroughly discussed under the UNFCCC, compared to the CBD, there has been little discussion on the links between REDD+ and indigenous peoples and local communities. However, in December 2015, the UNFCCC COP adopted decisions that included recognizing the need to strengthen knowledge, technologies, practices, and efforts of local communities and indigenous peoples related to addressing and responding to climate change, and which establish a platform for the exchange of experiences and sharing of best practices on mitigation and adaptation in a holistic and integrated manner (1/CP.21 paragraph 135). In May 2017, a multi-stakeholder dialogue on the operationalization of the local communities and indigenous peoples platform was held in conjunction with the 46th meeting of the UNFCCC Subsidiary Body for Scientific and Technological Advice.

Although there are differences among the three measures, existing research has shown co-benefits of climate change measures for certain fields, which were obtained by integrating mitigation and adaptation measures within the field of climate change (Berry et al., 2015; Duguma et al., 2014). Studies have also explored the co-benefits of integrating mitigation and conservation as well as adaptation and conservation (Munang et al., 2013; Phelps et al., 2012). Although the three measures are interlinked, there is limited research on the synergies among mitigation, adaptation, and conservation (Felton et al., 2016; Thompson, 2015).

This paper explores the synergy potential of those three areas in the forest sector through the following data and methods: 1) indicators that assess enabling conditions for synergies among mitigation, adaptation, and conservation, and 2) case studies from five countries in the Southeast Asian region, where forest conservation is one of the national priorities.

We focused on the forest sector because of its potential for producing synergies among mitigation, adaptation, and conservation (Chia et al., 2016; Thompson, 2015), and because there are a number of studies on mitigation, adaptation, and/or conservation in the forest sector. Within the forest sector, all three measures require forest conservation and management activities, but lack research on evaluating the synergies or trade-offs, which is important for eliminating overlaps among measures and enhancing their multiple benefits. Furthermore, we focused on the five Southeast Asian countries because they have potential for a more efficient implementation of forest conservation and management by enhancing synergies among mitigation, adaptation, and conservation measures; however, there is a lack of concrete discussion or research on these relationships in the five countries examined.

2. Literature review

As mentioned in the introduction, there are two types of analyses related to integration among mitigation, adaptation, and conservation. The first analyzes co-benefits in certain sectors by integrating measures (i.e., mitigation and adaptation measures) within the field of climate change (Valatin et al., 2016; Berry et al., 2015; Illman et al., 2013). The second type determines the co-benefits by integrating climate change and conservation (i.e., either integrating mitigation and conservation, or adaptation and conservation) (Munang et al., 2013; Phelps et al., 2012).

With regard to the synergies between mitigation and adaptation, for example, Berry et al. (2015) focused on Europe and analyzed interactions between adaptation and mitigation measures across the agricultural, biodiversity, coastal, forest, urban, and water sectors. They found that most mitigation and adaption measures have effects on other sectors, resulting in neutral, positive (synergies), or negative (conflicts) interactions within and between sectors; and that many local-scale measures could facilitate integration between both mitigation and adaptation. Further, the research underscored the importance of recognizing the cross-sectoral interaction of adaptation and mitigation measures if they are to be mainstreamed into policy to enhance positive

outcomes and avoid unintended consequences.

Illman et al. (2013) explored the opportunities and challenges related to promoting synergies and avoiding trade-offs between mitigation and adaptation from the perspective of climate finance. During the scoping study, they found no funding instruments with explicit and systematic aims of harnessing synergies (or systematic screening projects/programs and policies to avoid trade-offs). They recommended to: 1) conduct more empirical research on synergies to further define and concretize the benefits and challenges, 2) review the funding criteria of relevant climate funds, 3) link the concept of synergies with the climate mainstreaming agenda, and 4) pay attention to opportunities for catalyzing private sector climate action.

Valatin et al. (2016) applied a behavioral economic approach to consider the potential of "nudges" in encouraging woodland creation to help meet mitigation and adaptation goals. It is argued that such encouragements may best be tailored toward different types of land managers, taking into account differing attitudes, motivations, circumstances, and behaviors. They showed that, to be effective in enhancing woodland creation for mitigation and adaptation, likely requires a combination of woodland creation and other policy instruments.

For research on the relationship between mitigation and conservation, Phelps et al. (2012) provided a typology that characterizes the five underlying policy approaches for linking forest-based climate change mitigation and biodiversity conservation, and their related trade-offs. Their clarification will enable policymakers and stakeholders to better articulate their positions in the protracted and controversial debate on biodiversity co-benefits that is at the center of contemporary conservation efforts.

Makkonen et al. (2015) analyzed the coherence of Finnish policies (specifically, the interactions of different policy outputs) affecting forest bioenergy and carbon sequestration, two forest ecosystem services that mitigate climate change. They found that policies supporting bioenergy led to trade-offs between the two ecosystem services, whereas general policies advanced both services.

The literature on adaptation and conservation also includes Munang et al. (2013), who showed that ecosystem-based adaptation approaches were a cost-effective, robust, and flexible strategy for coping with the magnitude, speed, and uncertainty of climate change. These approaches have already proven their worth in many situations, and evidence is emerging of their success in helping people adapt to climate variability and change. With the impacts of climate change increasingly being felt worldwide, it is important to scale up the approach to increase society's resilience to climate change as well as to achieve more sustainable economic development.

Bele et al. (2015) focused on the linkages among climate change, tropical forests, and adaptation in Congo Basin. They demonstrated that: 1) Congo Basin forests are needed for adaptation, because they can help to decrease human vulnerability to climate change, and 2) Congo Basin forest management practices need to be adapted to accommodate climate change, because these forests are vulnerable to climate change. They recommended adopting a sustainable forest management approach that includes a climate change focus. Such management should not only avoid any adverse effects on forest resources and biodiversity conservation but also provide opportunities for greater, more sustainable rural development and poverty alleviation through income generation and employment opportunities.

Although mitigation, adaptation, and conservation are interlinked, there is limited research on the synergies among these measures (Felton et al., 2016; Thompson, 2015). Thompson (2015) described an overview of the science–policy interface among climate change, biodiversity, and terrestrial land use for production landscapes. The study illustrated that global progress in addressing climate change through mitigation and adaptation has been slow even though policy tools are available and most countries now have some climate change policies. Aside from the issues associated with developing strong climate action policies, the study concluded that, since there is a strong body of literature linking biodiversity to ecosystem resilience and goods and services, any policies dealing with mitigation and adaptation must consider the important role of biodiversity in terrestrial system recovery and management, including forests, agro-forests, and agricultural systems. Although intensive agriculture, forest restoration, and improved forest management contribute to mitigation, adaptation must be built into strategies for these to be effective over the long term, and must be based on an understanding of the complexity of biological systems. In production landscapes, policies need to consider the large landscape scale and be cross-sectoral in application, including among the forestry, agriculture, transportation, energy, and human health sectors. Policies discussed and developed cross-sectorally for large landscapes could avoid trade-offs between the agricultural and forestry sectors. The same study proposed a framework for incorporating science and local knowledge into policy at multiple levels, including the agricultural and forestry sectors, and recommended that local ecological knowledge and scientific information should form the basis for such policies.

Felton et al. (2016) evaluated the implications for forest biodiversity of climate change adaptation and mitigation strategies (CCAMS) implemented in the production forests of Sweden. They found that CCAMS will often come into direct or partial conflict with Swedish biodiversity goals in production forests. Furthermore, some CCAMS that are inconsistent with biodiversity goals, such as removal of logging residue, are being implemented more extensively than those that are most consistent with biodiversity goals. They nevertheless challenged the necessity of setting the preservation of forest biodiversity against climate change mitigation and adaptation.

Although Thompson (2015) described an overview of the science–policy interface among mitigation, adaptation, and biodiversity, and Felton et al. (2016) evaluated concerns on forest biodiversity associated with climate change policy, it is important to analyze effective ways to enhance synergies among mitigation, adaptation, and conservation, because there are policy and implementation overlaps among the three measures in the forest sector, which lead to inefficiencies in forest conservation and management.

Three qualitative methods have been used predominantly in the literature for evaluating the synergies or trade-offs specifically among mitigation, adaptation, and conservation: 1) case studies analyzing the conditions that produce such synergies or co-benefits; 2) analyses of different institutional levels that could potentially create synergies; and 3) reviews of the existing literature regarding synergies.

With regard to case studies, as described above, Berry et al. (2015) focused on Europe and analyzed interactions between adaptation and mitigation measures across the agricultural, biodiversity, coastal, forest, urban, and water sectors. Makkonen et al. (2015) analyzed Finnish policies affecting forest ecosystem services that mitigate climate change. Bele et al. (2015) analyzed the linkages among climate change, tropical forests, and adaptation using the case of Congo Basin forests. Thornton and Comberti (2013) used case studies from communities in Alaska and Nepal to illustrate current and potential synergies and trade-offs between mitigation and adaptation strategies, and to show how these might be harnessed to maximize benefits.

The analyses of different institutional levels include the research by Duguma et al. (2014), which proposed an analytical framework to assess enabling conditions for synergies between mitigation and adaptation, and explored a potential move toward synergy by analyzing the different institutional levels of policies and strategies, programs and projects, institutional arrangements, and financial mechanisms. The research showed that approximately half of the countries studied exhibited good synergy potential; of these, 80% were middle-income developing countries.

The literature includes categorizing studies that discuss the relationships between mitigation and adaptation and other effects in the forest sector, such as research on joint outcomes, unintended side

Table 1
Indicators that assess enabling conditions for synergies among the three measures.

Categories	Sub-categories (indicators)
1. Policies and Strategies	1–1 Does the country have a policy that addresses mitigation (*M*), adaptation (*A*), and biodiversity/ecosystem conservation (*BE)* in the forest sector?
	1–2 Is there a common strategy/action plan for *M*, *A*, and *BE* in the forest sector?
	1–3 Has the country submitted Nationally Appropriate Mitigation Actions (NAMAs)/Reducing Emissions from Deforestation and Forest Degradation in Developing Countries etc. (REDD +), a Readiness Preparation Proposal (R-PP), and National Adaptation Programmes of Action (NAPAs) to the UNFCCC and National Biodiversity Strategies and Action Plans (NBSAPs) to the CBD?
2. Institutional Arrangements	2–1 Is there a national-level committee addressing *M*, *A*, and *BE* in the forest sector?
	2–2 Is there an implementing body (e.g., institution, agency, department, and/or unit) addressing *M*, *A*, and *BE* in the forest sector?
3. Financing	3–1 Is there a common fund for *M*, *A*, and *BE* in the forest sector?
4. Programs and Projects	4–1 Is there a joint program addressing *M*, *A*, and *BE* in the forest sector?
	4–2 Are there subnational projects addressing *M*, *A*, and *BE* in the forest sector?

effects, and joint objectives (Locatelli et al., 2015). The review reveals a variety of reasons for mainstreaming mitigation and adaptation separately or jointly in landscape management, and the three broad conceptualizations of the links between mitigation and adaptation (joint outcomes, unintended side effects, and joint objectives) suggest different implications for climate policy mainstreaming and integration.

3. Analytical approaches

3.1. Analytical framework

To evaluate national synergy potential among the three discussed measures in the forest sector, we employed indicators based on those proposed by Duguma et al. (2014), who described the importance of creating an appropriate framework to analyze synergies between mitigation and adaptation, and enabling conditions at the national level. This is because, despite the promising potential of the synergy concept and the salient need for synergetic approaches for addressing climate change issues, there remains limited knowledge of on-the-ground implementation and the necessary conditions to make it possible. The eight indicators proposed by Duguma et al. (2014) could highlight progress toward synergy between mitigation and adaptation; they provide a schematic framework that considers the basic conditions necessary for a cross-sectoral policy, which can be implemented through hierarchical procedures from national to subnational to local levels.

Duguma et al. (2014) provide the only analysis, to date, of enabling conditions for synergies between mitigation and adaptation in developing countries; however, there are some limitations in evaluating national synergy potential among mitigation, adaptation, and conservation. The first is that the analytical framework of Duguma et al. (2014) focuses on mitigation and adaptation, but does not address conservation issues, which are required to analyze synergies among the three measures. The second limitation is the use of only eight indicators to analyze a country's synergy potential. The eight indicators are not able to capture whether synergy between mitigation and adaptation measures actually occurred, and whether they increased the effectiveness and efficiency in implementing the two measures. Furthermore, the eight indicators do not evaluate the effectiveness of different institutional levels of policies and strategies, programs and projects, institutional arrangements, and financial mechanisms. Third is the limitation of scoring the eight indicators. Duguma et al. (2014) summed the scores across all indicators; however, this does not take into account the differing importance of each indicator between different countries. Fourth is that the analysis only utilizes the review of National Communications (NCs) submitted to the UNFCCC, and an online questionnaire survey. Furthermore, it is difficult to compare the synergy potential in each country, as some information is outdated; each country's NC is submitted to the UNFCCC in different years. For example, Thailand's second NC was submitted in 2011, Indonesia in 2011, Vietnam in 2010, Lao People's Democratic Republic (PDR) in 2013, and Cambodia in 2016. Also, although Duguma et al. (2014) analyzed 53 countries, the online survey received only 30 responses, which is unlikely to make up for the limitations of NC data.

By understanding the strengths and limitations of the framework by Duguma et al. (2014), we first added conservation (biodiversity and ecosystem) as an indicator, and focused on the forest sector. Our indicators enable analysis of synergy potential among mitigation, adaptation, and conservation, all of which are important measures in the forest sector. Secondly, this analysis does not attempt to analyze the outcomes of synergies among the measures, or the effectiveness of institutions, because these usually emerge many years later, and cannot be evaluated by single and common indicators because they require behavioral and environmental indicators specific to the measures and institutions. Thirdly, although Duguma et al. (2014) summed the scores across all indicators, this study examined the questions (indicators) in Table 1, and analyzed them qualitatively, because it is difficult to evaluate each indicator quantitatively. Fourthly, as described in Section 3.2., we used qualitative data from legal documents and reports from the different institutional levels related to forest, climate change, and conservation which were published by 2016.

The indicators used to analyze national synergy potential among mitigation, adaptation, and conservation in the forest sector are summarized in Table 1. The evaluation is implemented by providing answers for each sub-category: “Yes” means yes to all three in the forest sector; “Partially” means yes to either mitigation (M) and adaptation (A), mitigation (M) and biodiversity/ecosystem conservation (BE), or adaptation (A) and biodiversity/ecosystem conservation (BE); and “No” means other.

3.2. Case studies

We applied the indicators shown in Section 3.1 to five countries in the Southeast Asian region where forest conservation is a vital and critical issue, comprising Thailand, Indonesia, Vietnam, Lao PDR, and Cambodia. We analyzed the possibility of generating synergies among mitigation, adaptation, and conservation in the forest sector via qualitative data from legal documents and reports from the different institutional levels of policies and strategies, institutional arrangements, financing, and programs/projects related to forest, climate change, and conservation.

While these five countries are all in Southeast Asia, they are at different stages of development; thus, it is necessary to understand their different synergy potentials. Thailand is an upper-middle income country; Indonesia, Vietnam, and Lao PDR are lower-middle income countries; and Cambodia is a low-income country (World Bank, 2016a). Lao PDR and Cambodia are considered least developed countries (LDCs). Notably, all five countries address forest conservation, climate change, and biodiversity conservation at the national level. Table A1 in Appendix A summarizes the basic information on each country.

The major data sources used in this study are as follows. For projects related to forest, climate change, and conservation, we used data from

the Organisation for Economic Co-operation and Development Creditor Reporting System database, and the Global Environment Facility (GEF) project database. We selected projects whose implementation periods include the years 2014–2016. The major data sources used for the case studies are summarized in Tables A2–A6 in Appendix A.

4. Results and discussion

In this section, we first summarize the results for each indicator, followed by a discussion of the synergy potentials of the five countries by comparing the results.

4.1. Indicators 1–1 and 1–2

Among the five countries, while none has a law that addresses all three measures (mitigation, adaptation, and conservation) in the forest sector simultaneously (*Indicator 1–1*), all five have existing national strategies/plans that enable that goal. The national strategies/plans that address the three measures in the forest sector simultaneously include strategies/plans on climate change and sustainable development. Although the national strategies/plans, such as those directed at climate change and sustainable development, address the three measures, they do not explicitly address the relationships or synergies among the three measures (*Indicator 1–2*).

4.2. Indicator 1–3

Thailand, Indonesia, and Vietnam are not LDCs, and therefore have no registered National Adaptation Programmes of Action (NAPA) processes, whereas Lao PDR and Cambodia have submitted NAPAs. Additionally, Thailand and Indonesia submitted national Nationally Appropriate Mitigation Actions (NAMAs) while Vietnam, Lao PDR, and Cambodia have not. Notably, this does not mean that the more developed countries focus only on mitigation and that less developed countries focus only on adaptation. In Thailand, Indonesia, and Vietnam, adaptation components are addressed under their national climate-change-related strategies. Furthermore, Vietnam (waste sector), Lao PDR (renewable energy), and Cambodia (garment industry) have NAMAs in specific sectors.

4.3. Indicator 2–1

Thailand and Vietnam have national councils that address the three measures in the forest sector simultaneously. However, although Indonesia, Lao PDR, and Cambodia have national-level councils/committees and taskforces that address mitigation/adaptation and/or mitigation/conservation in the forest sector, none of them address the three measures simultaneously.

4.4. Indicator 2–2

In Thailand, and in Indonesia, single ministries (Ministry of Natural Resources and Environment [MONRE] and Ministry of Environment and Forestry [MOEF]) address all forest, climate change, and conservation measures. With regard to Thailand, the Thai Government has introduced structural and administrative reforms to improve its bureaucracy, and MONRE was one of the 21 ministries established since 2002 (Jalonen et al., 2009). MONRE has given responsibility for natural resources and environment, and the Royal Forest Department, founded in 1896 was restructured into three departments under the MONRE (Jalonen et al., 2009). In the case of Indonesia, in 2014, during the administration of President Joko Widodo, the Ministry of Forestry was merged with the Ministry of Environment into MOEF (MOEF, 2017). The President, changed the climate policy architecture, and dismantled the Development Monitoring and Oversight, the National Council on Climate Change, and the REDD+ Agency (Di Gregorio et al., 2017). Some functions of the latter two were incorporated in the MOEF, which also established a Steering Committee on Climate Change (Di Gregorio et al., 2017).

Conversely, in Vietnam, Lao PDR, and Cambodia, individual ministries address environmental and forest-related problems, and have different purposes and roles. In Vietnam, MONRE addresses the three measures, while mitigation in the forest sector, which is REDD+, is mainly addressed by Vietnam's Administration of Forestry under the Ministry of Agriculture and Rural Development. In the case of Lao PDR and Cambodia, the system to manage REDD+ is still emerging. In Lao PDR, prior to the establishment of MONRE in 2012, REDD+ was addressed under the Department of Forestry (DOF) under the Ministry of Agriculture and Forestry. However, the REDD+ division was placed under the Department of Forest Protection and Restoration (DFRM) at MONRE, while the REDD+ office was under the DOF, following the establishment of MONRE (Mustalahti et al., 2017). In 2016, the Minister of MONRE officially transferred the DFRM to the Minister of MAF. The REDD+ division and office will be merged, and REDD+ will be addressed under the DOF (Mustalahti et al., 2017). In Cambodia, the REDD+ taskforce was chaired by the Forestry Administration under the Ministry of Agriculture, Forestry, and Fisheries (MAFF), and vice chaired by the Ministry of Environment (MOE) (CIF, 2017). Jurisdictional changes in 2016 and 2017 have transferred all protected areas from the MAFF to the MOE, while economic land concessions previously under MOE have been transferred to MAFF, and more than four million ha of land have been transferred between the two ministries (CIF, 2017), resulting in greater engagement of MOE in addressing REDD+.

4.5. Indicator 3–1

There is a limited number of active common funds at the national level. There are no active common funds in Thailand and Lao PDR; Vietnam has a fund that addresses all three measures in the forest sector; and Indonesia and Cambodia have a common fund that addresses mitigation and adaptation in the forest sector.

4.6. Indicator 4–1

At the national level, Thailand has no active joint programs. Indonesia has joint programs on mitigation and conservation. Vietnam and Cambodia have joint programs that address the three measures. Lao PDR has joint programs that address mitigation/adaptation and mitigation/conservation. Regarding joint programs that address mitigation and conservation, there are particular programs related to REDD+, which are more active in Indonesia, Vietnam, Lao PDR, and Cambodia as compared to in Thailand. REDD+ not only contributed to mitigation but also to biodiversity conservation through its safeguard system. Additionally, the joint programs that address adaptation and conservation are related to ecosystem-based adaptation.

4.7. Indicator 4–2

Lastly, Vietnam and Lao PDR have subnational projects that address the three measures in the forest sector simultaneously. Indonesia and Cambodia have projects that address both mitigation/conservation and adaptation/conservation. In Thailand, there are only projects that address mitigation in combination with conservation.

Tables 2–6 show detailed results from the case study of each country.

By comparing the results, this analysis suggests the need for institutional changes that will enhance the synergy potentials among the three measures in the forest sector. At the national level, although the five countries lack holistic laws that address all mitigation, adaptation, and conservation measures in the forest sector, there are national strategies/plans that address all three measures. However, these

Table 2
Results of the analysis for Thailand.

Indicators	Evaluation				
	Overall	*M*, *A*, and *BE*	*M* and *A*	*M* and *BE*	*A* and *BE*
1–1 Policy	No	No	No	No	No
		No law addresses all *M*, *A*, and *BE*; none addresses either *M* and *BE* or *A* and *BE*.			
1–2 Strategy/Action Plan	Yes	Yes	Yes	Yes	Yes
		E.g., the National Economic and Social Development Plan 2012–2016 addresses all *M*, *A*, and *BE*; the Thailand Climate Change Master Plan 2015–2050 addresses *M* and *A*.			
1–3 Action Plan to UNFCCC and CBD	Partially	Partially	Partially	Partially	Partially
		No NAPA (because Thailand is a non-LDC) is registered.			
2–1 National Council	Yes	Yes	Yes	Yes	Yes
		E.g., the National Council for Sustainable Development and the National Environmental Board both address *M*, *A*, and *BE*.			
2–2 National Implementing Bodies	Yes	Yes	Yes	Yes	Yes
		E.g., the Ministry of Natural Resources and Environment addresses *M*, *A*, and *BE* in the forest sector.			
3–1 Common Fund	No	No	No	No	No
		There is no active common fund at the national level.			
4–1 Joint Program	No	No	No	No	No
		There is no active program at the national level.			
4–2 Subnational Projects	Partially	No	No	Yes	No
		There are projects only addressing *M* and *BE*, such as GEF's project named "Maximizing carbon sink capacity and conserving biodiversity through sustainable conservation, restoration, and management of peat-swamp ecosystems."			

national strategies/plans do not explicitly address the relationships or synergies among the three, and it is unlikely that national strategies/plans alone will enhance such synergy.

A key point in enhancing synergy is the role of national actors, such as national-level committees and implementing bodies, which can address these three measures. Among the five countries only Thailand has national councils addressing the three measures in the forest sector simultaneously together with a single ministry with responsibility for all three measures. All five countries currently have national committees, councils, or taskforces that address mitigation and adaptation and/or mitigation and conservation. Thailand and Vietnam have national councils that address the three measures in the forest sector simultaneously. The other three countries need to create national-level committees to address the three measures. On the other hand, in Thailand and Indonesia, one ministry addresses all forest conservation, climate change, and conservation issues. Murdiyarso (2014) describes that a single ministry, such as MOEF in Indonesia, could be more politically powerful than two smaller ministries (Ministry of Environment and Ministry of Forestry) provided that the available resources are optimized and/or mobilized to meet the new and common goal. On the

Table 3
Results of the analysis for Indonesia.

Indicator	Evaluation				
	Overall	*M*, *A*, and *BE*	*M* and *A*	*M* and *BE*	*A* and *BE*
1–1 Policy	No	No	No	No	No
		No law addresses all *M*, *A*, and *BE*; none addresses either *M* and *BE* or *A* and *BE*.			
1–2 Strategy/Action Plan	Yes	Yes	Yes	Yes	Yes
		E.g., the National Action Plan Addressing Climate Change and National Medium Term Development Plan 2015–2019 address all *M*, *A*, and *BE*.			
1–3 Action Plan to UNFCCC and CBD	Partially	Partially	Partially	Partially	Partially
		No NAPA (because Indonesia is a non-LDC) is registered.			
2–1 National Council	Partially	No	Yes	No	No
		The Steering Committee on Climate Change addresses *M* and *A*.			
2–2 National Implementing Bodies	Yes	Yes	Yes	Yes	Yes
		E.g., the Ministry of Environment and Forestry addresses all *M*, *A*, and *BE* in the forest sector.			
3–1 Common Fund	Partially	No	Yes	No	No
		There are only common funds that address *M* and *A* in the forest sector, such as the Indonesia Climate Change Trust Fund.			
4–1 Joint Program	Partially	No	No	Yes	No
		There are only joint programs that address *M* and *BE*, including the Federal Ministry for Economic Cooperation and Development (BMZ) Forests and Climate Change Programme.			
4–2 Subnational Projects	Partially	No	Yes	Yes	Yes
		The subnational programs that address *M* and *A* include Norwegian Agency for Development Cooperation (Norad) Secured Landscapes-Sustaining Ecosystem and Carbon Benefits, programs that address *M* and *BE* include GEF Strengthening Forest Area Planning and Management in Kalimantan, and programs that address *A* and *BE* include GEF Sustainable Forest and Biodiversity Management in Borneo.			

Table 4
Results of the analysis for Vietnam.

Indicator	Evaluation				
	Overall	*M*, *A*, and *BE*	*M* and *A*	*M* and *BE*	*A* and *BE*
1–1 Policy	No	No	No	No	No
		No law addresses all *M*, *A*, and *BE*; none addresses either *M* and *BE* or *A* and *BE*.			
1–2 Strategy/Action Plan	Yes	Yes	Yes	Yes	Yes
		E.g., the Vietnam Sustainable Development Strategy for 2011–2020 and the National Climate Change Strategy address all *M*, *A*, and *BE*.			
1–3 Action Plan to UNFCCC and CBD	Partially	Partially	Partially	Partially	Partially
		No national NAMA and NAPA (because Vietnam is a non-LDC) are registered.			
2–1 National Council	Yes	Yes	Yes	Yes	Yes
		E.g., the National Council on Sustainable Development addresses *M*, *A*, and *BE*.			
2–2 National Implementing Bodies	Partially	Partially	Partially	Partially	Partially
		E.g., the Ministry of Natural Resources and Environment addresses *M*, *A*, and *BE*. *M* in the forest sector is mainly addressed by Vietnam's Administration of Forestry under the Ministry of Agriculture and Rural Development.			
3–1 Common Fund	Yes	Yes	Yes	Yes	Yes
		E.g., the Vietnam forest protection and development fund addresses *M*, *A*, and *BE* in the forest sector.			
4–1 Joint Program	Yes	Yes	Yes	Yes	Yes
		E.g., the National Target Program to Respond to Climate Change addresses all *M*, *A*, and *BE*.			
4–2 Subnational Projects	Yes	Yes	Yes	Yes	Yes
		E.g., the BMZ Sustainable Forest Management + Biodiversity as a Measure to decrease CO_2 addresses all *M*, *A*, and *BE*.			

other hand, there are concerns, such as difficulties in harmonizing units from two ministries, orchestrating numerous legal instruments including law on forestry versus environmental protection and management (Murdiyarso, 2014), and also concerns that Indonesia's conservation agenda will languish under the weight of MOEF's bureaucracy (Saturi, 2015). However, the establishment of a single ministry could address the three measures more efficiently than in Vietnam, Lao PDR, and Cambodia, because it would avoid problems of coordination between ministries, and also the unstable jurisdictional changes between ministries as in Lao PDR and Cambodia, mentioned above. In Vietnam, Lao PDR, and Cambodia, these problems are addressed under the two ministries that address environmental problems and forest-related problems. This creates obstacles to comprehensive oversight of the three measures. Greater collaboration between the ministries that address the environment and forestry is important to overcome the gaps in addressing the three measures.

Regarding financing and program/project levels, Vietnam is evaluated as having the highest synergy potential, and Thailand the lowest. As mentioned above, Thailand, Indonesia, Lao PDR, and Cambodia lack active common national funds that address the three measures in the forest sector simultaneously; in contrast, Vietnam has a fund that addresses the three measures. With the exception of Vietnam, these countries need to develop common national funds to finance the three measures in the forest sector. In terms of programs and projects, all five

Table 5
Results of the analysis for Lao PDR.

Indicator	Evaluation				
	Overall	*M*, *A*, and *BE*	*M* and *A*	*M* and *BE*	*A* and *BE*
1–1 Policy	No	No	No	No	No
		No law addresses all *M*, *A*, and *BE*; none addresses either *M* and *BE* or *A* and *BE*.			
1–2 Strategy/Action Plan	Yes	Yes	Yes	Yes	Yes
		E.g., National Strategy on Climate Change of Lao PDR addresses all *M*, *A*, and *BE*.			
1–3 Action Plan to UNFCCC and CBD	Partially	Partially	Partially	Partially	Partially
		No national NAMA is registered.			
2–1 National Council	Partially	No	Yes	Yes	No
		E.g., the National Steering Committee on Climate Change addresses *M* and *A*, and the REDD+ Taskforce addresses *M* and *BE*.			
2–2 National Implementing Bodies	Partially	No	Yes	Yes	Yes
		E.g., the Ministry of Natural Resources and Environment addresses *M*, *A*, and *BE*; however, *M* in the forest sector is addressed by both the Department of Forestry under the Ministry of Agriculture and Forestry and the Ministry of Natural Resources and Environment.			
3–1 Common Fund	No	No	No	No	No
		There is no active common fund at the national level.			
4–1 Joint Program	Partially	No	Yes	Yes	No
		E.g., the Lao PDR Global Climate Change Alliance addresses *M* and *A*, and the World Bank Forest Investment Program addresses *M* and *BE*.			
4–2 Subnational Projects	Yes	Yes	Yes	Yes	Yes
		E.g., both the GEF Integrating Biodiversity Conservation and Climate Resilience and Sustainable Forest Management in Central Annamite Landscapes address all *M*, *A*, and *BE*.			

Table 6
Analysis of Cambodia.

Indicator	Evaluation				
	Overall	*M*, *A*, and *BE*	*M* and *A*	*M* and *BE*	*A* and *BE*
1–1 Policy	No	No	No	No	No
	No law addresses all *M*, *A*, and *BE*; none addresses either *M* and *BE* or *A* and *BE*.				
1–2 Strategy/Action Plan	Yes	Yes	Yes	Yes	Yes
	E.g., the Cambodia Climate Change Strategic Plan 2014–2023 addresses all *M*, *A*, and *BE*.				
1–3 Action Plan to UNFCCC and CBD	Partially	Partially	Partially	Partially	Partially
	No national NAMA is registered.				
2–1 National Council	Partially	No	Yes	Yes	No
	National councils that address *M* and *A* include the National Climate Change Committee, and the taskforces that addresses *M* and *BE* include the REDD+ Taskforce.				
2–2 National Implementing Bodies	Partially	Partially	Partially	Partially	Partially
	E.g., the Ministry of Environment addresses *M*, *A*, and *BE*; however *M* in the forest sector is addressed by both Ministry of Environment and the Forestry Administration under the Ministry of Agriculture, Forestry, and Fisheries.				
3–1 Common Fund	Partially	No	Yes	No	Yes
	Common funds that address *M* and *A* include the Cambodia Climate Change Alliance Trust Fund, and funds that address *A* and *BE* include the Cambodia Climate Change Alliance Trust Fund.				
4–1 Joint Program	Yes	Yes	Yes	Yes	Yes
	E.g., the National Forest Programme addresses all *M*, *A*, and *BE*.				
4–2 Subnational Projects	Partially	No	No	Yes	Yes
	Subnational programs that address *M* and *BE* include the GEF Strengthening National Biodiversity and Forest Carbon Stock Conservation through Landscape-based Collaborative Management of Cambodia's Protected Area System, as demonstrated in the Mondulkiri Conservation Landscape project, and the program that addresses *A* and *BE* include the Conservation International Adapting to Environmental Change in the Tonle Sap Lake in Cambodia project.				

countries receive funds from financial mechanisms such as the Global Environment Facility (GEF), and aid agencies such as the Federal Ministry for Economic Cooperation and Development (BMZ), and are trying to enhance synergies among the three measures. Thailand has established projects addressing only mitigation and conservation, while Vietnam has programs and projects that address the three measures simultaneously. The other countries analyzed here have programs and projects that address any two of the three measures but not all three in combination. Joint programs and projects that address all three measures need to be developed.

This analysis shows it is likely that the synergies between mitigation and conservation as well as between adaptation and conservation are promotable through existing funds, programs, and projects related to REDD+ or ecosystem-based adaptation. Although REDD+ aims at mitigation (as mentioned above, REDD+ not only contributed to mitigation but also to biodiversity conservation through its safeguard system) and ecosystem-based adaptation aims at adaptation, these measures could enhance ties between climate change and conservation measures.

The findings do not rank the overall degree of synergy potential of each country, and no correlations were found between synergy potential and the developmental stage of the five countries. However, the analysis showed that Thailand has the highest synergy potential due to its national-level committees and a ministry that addresses all three measures. Regarding financing and program/project aspects, Vietnam has the highest synergy potential because it is the only country with both programs and projects that jointly address mitigation, adaptation, and conservation. This analysis shows that all five countries require changes at the different institutional levels in order to enhance synergy potentials among the three measures in the forest sector.

This analysis contributes to developing the field of research on institutional linkages among mitigation, adaptation, and conservation in the forest sector; and to resolving the lack of policy discussion and research on synergies among these three measures within the five case study countries (for example, climate change and conservation policies are discussed separately, e.g., Thi et al., 2017; Zimmer et al., 2015). In this paper, we discussed the kinds of institutional changes necessary to enhance synergy potentials among mitigation, adaptation, and conservation in the forest sector. However, to achieve such institutional changes in practice, it is also important to discuss the following two questions: 1) Why do developing countries lack proper policies and strategies to simultaneously address three measures in the forest sector? 2) Why do few financial mechanisms, programs, and projects simultaneously address the three measures in the forest sector?

The following are considered the main factors for the first issue:

- There are no clear (quantitative) data showing how cost-effectiveness is improved by enhancing synergies among the three measures.
- Since there is no convention that addresses forest sector issues comprehensively, there is limited international pressure on developing countries to enhance the synergies among the three measures.
- Many of the national policies and strategies in developing countries are established by consulting with aid agencies, including international organizations and NGOs, few of which take into account enhancing synergies among the three measures.

With regard to the second question, the main factors are:

- Each financial scheme, program, and project has a different focus, including different environmental benefits (e.g., benefits of mitigation, adaptation, and conservation), forest conservation and management, and the economic benefits of forestry.
- Aid agencies and existing financial mechanisms emphasize the effects of these programs and projects, and lack good models or case studies for implementing cost-effective programs and projects by enhancing the synergies among the three measures in developing countries.

In order to develop our analysis of synergy potential among mitigation, adaptation, and conservation in the forest sector, future

analytical tasks are as follows. First is evaluating the effectiveness of institutions. In this analysis, we did not evaluate the effectiveness of institutions because the effects usually only emerge many years later, and cannot be evaluated by single and common indicators because they require behavioral and environmental indicators depending on each institution. However, in enhancing synergy among the three measures in each country, it is important to understand which institutions have effects on the three measures. One way to analyze the behavioral and environmental effects of institutions could be to conduct interviews with experts within the government, aid agencies, and NGOs operating in each country. Second is analyzing the role of local institutions and actors. Our analysis focused on national-level institutions and actors because influential policies on the three measures are usually discussed at the national level. Nevertheless, the role of local actors, including local governments, in enhancing synergy among the three measures, also needs to be discussed. As mentioned previously, adaptation and conservation mainly produce regional and local benefits. Therefore, local institutions and actors could also contribute to enhancing the synergies among the three measures. Third is exploring quantitative indicators for analyzing synergy potentials among the three measures. The present study mainly utilizes qualitative analysis; however, quantitative indicators are necessary for comparing a large number of countries.

5. Conclusions

This study explored the potential for synergy among three measures in the forest sector, utilizing: 1) indicators that assess synergistic conditions among the three measures at the different institutional levels; and 2) case studies of five countries in Southeast Asia: Thailand, Indonesia, Vietnam, Lao PDR, and Cambodia.

The analysis showed that the five countries all require various changes at different institutional levels in order to enhance their synergy potentials. The findings indicate the importance of national actors, financial mechanisms, and programs and projects in addressing the three measures. In terms of national actors, Thailand has the highest synergy potential among the three measures, because it has national-level committees and a single ministry that addresses all three measures. To enhance their synergy potentials, the other four countries need to create similar national-level committees and/or enhance collaboration between the various ministries that address environmental and forestry issues.

At the financing and program/project levels, Vietnam has the highest synergy potential. The other four countries need to develop common national funds that finance the three measures and/or develop joint programs and projects that address the three measures simultaneously.

Future analytical tasks should include: 1) evaluating the effectiveness of institutions; 2) analyzing the role of local institutions and actors; and 3) exploring quantitative indicators for analyzing the synergy potential among the three measures.

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Appendix A. Data sources of case studies

Appendix A shows the data sources for the case studies. Table A1 shows the basic information on the five countries. Tables A2–A6 show the major data sources for the case studies.

Table A1
Basic information of five countries.

	Gross Development Product (GDP) (current USD; World Bank, 2016a)	Population (in 2014)	Forest Areas (in 2013; World Bank, 2016b)
Thailand	404.8 billion	67.73 million	32% of Thailand land areas
Indonesia	888.5 billion	254.4 million	51% of Indonesia's land areas
Vietnam	186.2 billion	90.73 million	47% of Vietnam's land area
Lao PDR	12 billion	6.69 million	80% of Lao PDR's land area
Cambodia	16.78 billion	15.33 million	55% of Cambodia's land area

Table A2
Major data sources used for the case study of Thailand.

Categories	Sources
Laws	Forest Act (1941), National Reserved Forest Act (1964), Commercial Forest Plantation Act (1992), Enhancement and Conservation of National Environmental and Quality Act (1992), Wildlife Preservation and Protection Act (1992)
National Strategies	Thai Forestry Sector Master Plan (1993), National Biodiversity Strategy and Action Plan (NBSAP) to the CBD (2008), National Economic and Social Development Plan 2012–2016 (2012), Reducing Emissions from Deforestation and Forest Degradation in Developing Countries etc. (REDD +) Readiness Preparation Proposal (R-PP) (2013), Country Partnership Strategy 2013–2016 (2013), National Strategy on Climate Change 2013–2017 (2013), Thailand's Nationally Appropriate Mitigation Actions (NAMA) (2014), Thailand Climate Change Master Plan 2015–2050 (2015)
Programs and Projects	Programs and projects under the ministries, such as the Ministry of Natural Resources and Environment, and the GEF and aid agencies such as BMZ and Non-governmental organizations (NGOs).

Table A3
Major data sources used for the case study of Indonesia.

Categories	Sources
Laws	Act on the Conservation of Biological Resources and their Ecosystems (1990), Act on Environmental Management (1997), Act on Forestry Affairs (1999), Government Regulation on Forest Arrangement and Formulation of Forest Management Plan as well as Forest Exploitation (2007), Government Regulation on the Use of Forest Areas (2010)
National Strategies	Indonesian Biodiversity and Action Plan 2003–2020 (2003) (which is NBSAP to the CBD), National Long Term Development Plan 2005–2025 (2005), National Action Plan Addressing Climate Change (2007), REDD + R-PP (2009), National NAMA (2010), Indonesia Climate Change Sectoral Roadmap (2010), REDD + National Strategy (2012), National Action Plan on Climate Change Adaptation (2013), National Medium Term Development Plan 2015–2019 (2014)
Programs and Projects	Programs and projects under the ministries, such as the Ministry of Environment and Forestry, and the GEF and aid agencies such as the BMZ and Norad, and NGOs

Table A4
Major data sources used for the case study of Vietnam.

Categories	Sources
Laws	Law on Forest Protection and Development (1991), Law on Land (2003), Law on Forest Protection and Development (2005), Biodiversity Law (2008)
National Strategies	Vietnam Forestry Development Strategy 2006–2020 (2007), National Target Program to Respond to Climate Change (2008), National Climate Change Strategy (2011), REDD + R-PP (2011), Vietnam Sustainable Development Strategy for 2011–2020 (2012), National Strategy for Environmental Protection until 2010 and vision toward 2020 (2012), National Action Programme on REDD + 2011–2020 (2012), National Biodiversity Strategy to 2020, vision toward 2030 of Vietnam to the CBD (2015)
Programs and Projects	Programs and projects under ministries, such as the Ministry of Natural Resources and Environment and the Ministry of Agriculture and Rural Development, and the GEF and aid agencies such as BMZ and NGOs

Table A5
Major data sources used for the case study of Lao PDR.

Categories	Sources
Laws	Forestry Law (1996, 2007 revision), Land Law (1997, 2003 revision), Environmental Protection Law (1999, 2009 revision), Wildlife and Aquatic Law (2007)
National Strategies	National Growth and Poverty Eradication Strategy (2004), National Environment Strategy to 2020 and Action Plan 2010 (2004), National Biodiversity Strategy to 2020 and Action Plan 2010 (2004), Lao PDR Forestry Strategy 2020 (2005), Lao PDR National Sustainable Development Strategy (2008), National Adaptation Programme of Action (NAPA) (2009), REDD + R-PP (2010), Lao PDR Agricultural Development Strategy 2011–2020 (2010), National Strategy on Climate Change of Lao PDR (2010), National Socio-economic Development Plan 2011–2015 (2011)
Programs and Projects	Programs and projects under the ministries, such as the Ministry of Natural Resources and Environment and the Department of Forestry under the Ministry of Agriculture and Forestry, and the GEF and aid agencies such as the World Bank and NGOs

Table A6
Major data sources used for the case study of Cambodia.

Categories	Sources
Laws	Law on Environmental Protection and Natural Resource Management (1996), Land Law (2001), Law on Forestry (2002)
National Strategies	NAPA (2006), Protected Area Law (2008), NBSAP (2002), National Forest Program 2010–2030 (2010), Cambodia REDD + Roadmap (2011), Rectangular Strategy for Growth, Employment, Equity, and Efficiency Phase III (2013), Cambodia Climate Change Strategic Plan 2014–2023 (2013), REDD + R-PP (2013), National Strategic Development Plan 2014–2018 (2014), Climate Change Action Plan for the Ministry of Environment 2016–2018 (2016)
Programs and Projects	Programs and projects under ministries, such as the Ministry of Environment and the Forest Administration under the Ministry of Agriculture, Forestry, and Fisheries, and the GEF and aid agencies such as the United Nations Development Programme and NGOs

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